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REVISION OF THE TYPE SPECIES OF THE ORDOVICIAN NUCULOID PELECYPOD GENUS *TANCREDIOPSIS*

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ABSTRACT

The type species of the early Paleozoic nuculoid pelecypod genus *Tancrediopsis* Beushausen, 1895, is shown to be *Ctenodonta contracta* Salter, 1859, from Middle Ordovician rocks of southern Quebec, Canada. This species is redescribed from a series of 189 well-preserved silicified specimens, about half of which were collected at the original type locality. This large sample permits the definition of limits of variation in the species and reveals previously unknown morphologic features, among which are strong pedal muscle scars and external escutcheonal perforations. The species is easily confused with closely related sympatric species of *Tancrediopsis,* and criteria are discussed for distinguishing it from these similar forms. The correct name for *"Ctenodonta" contracta* Salter is shown to be *Tancrediopsis cuneata* (Hall).

INTRODUCTION

This paper is the first in a projected series to be devoted to generic-level revisions of the systematics and phylogeny of Paleozoic nuculoid pelecypods. As a vital first step toward clarifying the early history of this common and long-ranging group, a restudy is being made of the type species of each generic name that has been proposed for Paleozoic nuculoids.

This redescription of the generic type species is being patterned directly on a study of Paleozoic gastropod type species which has been compiled by Knight (1941). As in Knight's work, it is planned to make these redescriptions as objective as possible by basing them only on known original specimens of the species involved (see Knight, 1941, p. 1, for an excellent discussion of the value of objectivity in such work). An exhaustive search of the literature has indicated that about 60 names have been proposed for Paleozoic pelecypod genera which have at sometime been considered to show taxodont dentition or other evidence of nuculoid affinities.[1] The redescription of the primary types of the type species of these genera is now about half completed, and it is expected that these revisions will be submitted for publication as one unit within a year.

As a further step toward understanding the morphology, adaptations, and phylogeny of Paleozoic nuculoid genera, a much longer range program is planned for assembling and studying additional non-type material of the type species of many of these genera. In this program, particular emphasis will be placed on genera that cannot be adequately understood from the surviving original type specimens. Every effort will be made to assemble enough material of each species to permit the application of modern concepts of population systematics for determining the true nature and variability of specific and generic characters. It is planned to publish these more comprehensive revisions intermittently, one genus at a time, as adequate material of the type species can be assembled. This paper is the first of this series of type species revisions based on additional material that was not available to the original author of the species. It treats the common Ordovician nuculoid genus *Tancrediopsis* Beushausen (1895), whose type

[1] The term "nuculoid" is used here in the broadest sense to include all *Nucula*-like forms from Paleozoic rocks. In practice, this means all Paleozoic pelecypods with taxodont dentition, because the convergent development of such dentition in other unrelated groups, such as arcids and the fresh-water genus *Iridina,* did not take place until after the close of the Paleozoic. As thus defined, "nuculoid" is approximately equivalent to the Subclass Protobranchiata (other than the Solemyidae) which has recently been suggested to include all pelecypods with protobranch ctenidia (see Cox, 1959).

species, *Ctenodonta contracta* Salter (1859), has never been adequately understood.

This revision of *Ctendonta contracta* is based on Salter's 15 original specimens from the Geological Survey of Canada collections, supplemented by an excellent series of 174 silicified specimens from the collections of the Yale Peabody Museum. About half of these additional specimens are from the original type locality of the species. The Yale material was collected in the early years of this century by C. E. Beecher and P. E. Raymond as a part of an ambitious program of restudy of important silicified early Paleozoic faunas of eastern North America. Many hundreds of pounds of rock from several localities were collected and etched, but the program was cut short by Beecher's untimely death in 1904, with the result that this great wealth of material has never been studied. The etched Middle Ordovician collections have now been sorted for pelecypods and have yielded about 1500 identifiable specimens. These collections are particularly rich in well-preserved nuculoid species, and it is expected that this material will provide a basis for future studies on the earliest evolutionary radiation of this important group of pelecypods.

I am most grateful to the National Science Foundation for support of these studies of Paleozoic nuculoid pelecypods under its Program for Systematic Biology, Division of Biological and Medical Sciences (Grant No. G19961). I am also greatly indebted to D. J. McLaren, T. E. Bolton, and G. W. Sinclair of the Geological Survey of Canada for the loan of Salter's types and for generous cooperation on this project. Finally, I wish to thank D. W. Harvey and Martha Erickson for their skillful preparation of the photographs and drawings, and C. J. Durden, who made the preliminary sorting of the silicified Peabody Museum material.

Genus *TANCREDIOPSIS*

Author. Beushausen, 1895, p. 70.

Type Species. *Ctenodonta contracta* Salter (1859, p. 37) [=*Tellinomya cuneata* Hall, 1856, p. 392] by subsequent designation of Cossmann, 1897, p. 94.

Discussion. Most Ordovician nuculoid pelecypods have been described under the generic name *Ctenodonta* Salter, 1852, which has as its type the large and distinctive, but rather uncommon Ordovician species *Ctenodonta nasuta* (Hall), 1847 (see Wilson, 1956, pl. 2 for illustrations of this species). In an attempt to subdivide further the complex of species traditionally assigned to "*Ctenodonta*," Beushausen proposed the subgeneric name *Tancrediopsis* for more common, smaller, early Paleozoic nuculoids typified by the Ordovician species *Ctenodonta contracta* Salter (1859) and the Silurian species *Nucula sulcata* Hisinger (1841), both of which were originally designated by Beushausen as the "types" of his new subgenus. The first subsequent designation of one of these species as the type of the subgenus was made by Cossmann two years after the original description (1897, p. 94), when he chose *Ctenodonta contracta* Salter as the type species. It will be shown later that the correct name for this species is *Tancrediopsis cuneata* (Hall).

Beushausen's name *Tancrediopsis* seems to have been ignored by all later workers on Ordovician pelecypods, but it has gained some usage as a generic name with workers describing Silurian and Devonian nuculoids (Prosser and Kindle, 1913; McLearn, 1924; Reed, 1931; Northrop, 1939; Sherrard, 1960). In this regard it should be noted that even though Beushausen originally named an Ordovician and a Silurian species as the "types" of the subgenus, the name was proposed to facilitate the description of Devonian species which were the subject of his monograph. While it is still too early to determine the final usefulness of the generic name, it appears likely that many of the post-Ordovician species to which it has been applied cannot be considered as congeneric with the type species, "*Ctenodonta contracta*." The name *Tancrediopsis* will, however, probably prove useful in the future as a generic subdivision of the heterogeneous assemblage of Ordovician forms now included in "*Ctenodonta*." Here again, a final determination of the value of the name must await further study of other genera and species of Ordovician nuculoids. In anticipation of such studies it appears that many Ordovician nuculoid species show closer affinities to

"*Ctenodonta contracta*," the type of *Tancrediopsis*, than to *Ctenodonta nasuta*, the distinctive and uncommon type of the genus *Ctenodonta*. For this reason, the transfer of many Ordovician species from *Ctenodonta* to *Tancrediopsis* may prove desirable in future revisions.

Tancrediopsis cuneata (Hall)

Figures 1-80

Tellinomya cuneata Hall, 1856, p. 392, figs. 6, 7. Hall, 1857a, p. 183, figs. 6, 7. Hall, 1857b, p. 143, figs. 6, 7. [not] Hall, 1862, p. 38, figs. 1, 2.

Ctenodonta contracta Salter, 1859, p. 37, pl. 8, figs. 4, 5. Logan, 1863, p. 175, figs. 160a, 160b. Wilson, 1956, p. 23, pl. 2, figs. 7-9.

Ctenodonta (Tancrediopsis) contracta (Salter). Beushausen, 1895, p. 70.

[?] *Tellinomya contracta?* (Salter). Walcott, 1884, p. 76, pl. 11, figs. 15, 15a.

Revised description. Shell of small size (median height of 136 measurable specimens 8 mm), equivalved, strongly convex, thick and massive, constricted posteriorly.[2] Shape variable, height ranging from 62 to 86 per cent of length (median of 86 measurable specimens 71 per cent). Surface sculpture of very fine, widely spaced concentric ridges which are commonly divided into rod-like pustules, especially near the outer margin (figs. 4-7, 18, 19, 24, 26, 28, 35, 37). Sculpture usually obscure or absent, probably because of difficulty of preservation rather than absence on original shell. The dorsal margin shows a prominent oval lunule anterior to the umbones and a more elongate and obscure posterior escutcheon (figs. 65-73). Lunule and escutcheon variable in size and shape. Strong, chevron-shaped, taxodont dentition with approximately equal num-

[2] By analogy with living nuculoids, the smaller, contracted end of *T. cuneata* is considered to be posterior and the larger end to be anterior as shown in figs. 1 and 2.

bers of teeth on both sides of umbo, teeth decreasing abruptly in size but apparently continuous in umbonal region (figs. 46-64, 73-80). One well-preserved specimen shows several tiny perforations along the margins of the escutcheon, probably representing an extreme elongation of the dental sockets (fig. 71; see Sorgenfrei, 1937, and Trueman, 1952, for discussions of similar structures in Cenozoic nuculoids). Resilifer absent. Several specimens show a strong, external ligament structure preserved as a silicified replica along the anterior third of the escutcheon posterior to the umbones (figs. 65-67, 69, 70, 72, 80). Strong, subequal adductor scars deeply impressed into the thick shell material, bounded on interior side by thickened shell material making raised ridge which is most prominent behind the anterior scar (figs. 75-80). Two small but deeply impressed subequal pedal muscle scars occur just below the hinge plate at the dorsal end of these adductor ridges (figs. 74-80). A few well-preserved specimens also show faint impressions just below the posterior hinge plate which may represent other pedal or visceral muscle scars (figs. 75, 77). Pallial line not preserved, probably very faint or absent on original shell material. Original calcareous shell material unknown, replaced by amorphous silica in all specimens.

Types. Lectotype of *Tellinomya cuneata* Hall, here designated, the specimen shown by Hall, 1856, as fig. 7 (and fig. 6 if both figures represent the same specimen), p. 392; whereabouts unknown. Type locality: "Pauquette's Rapids on the Ottawa River" [between Allumette Island, Quebec and Ontario mainland, about three miles south of Waltham, Quebec, Canada (see Kay, 1942, pl. 6)]. Stratigraphic position: "Beds lying at the junction of the Trenton and Black River limestones" [Rockland beds of the Ottawa formation, Middle Ordovician (lower Trenton stage of Twenhofel, 1954)]. Lectotype of *Ctenodonta contracta* Salter, by designation of Wilson, 1956, p. 23, No. 1171b in the collections of the Geological Survey of Canada, Ottawa, Ontario, Canada. This specimen is one of Salter's original syntypes which was figured by him (1859)as pl. 8, figs. 5, 5a. Type locality: "Allumette Islands,"

Quebec [probably Paquette Rapids between Allumette Island, Quebec and Ontario mainland, about three miles south of Waltham, Quebec, Canada (see Kay, 1942, pl. 6)]. Stratigraphic

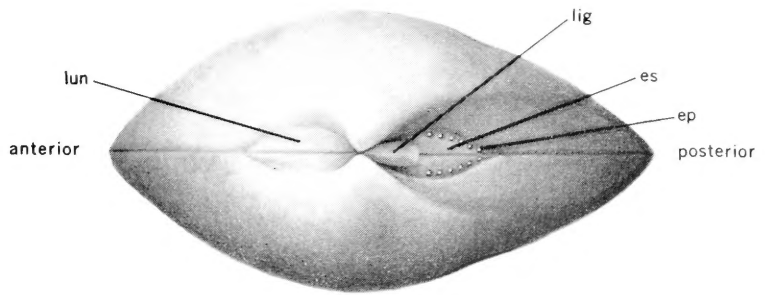

Figure 1. *Tancrediopsis cuneata* (Hall). Generalized dorsal view of articulated valves showing lunule (lun), ligament (lig), escutcheon (es) and escutcheonal perforations (ep).

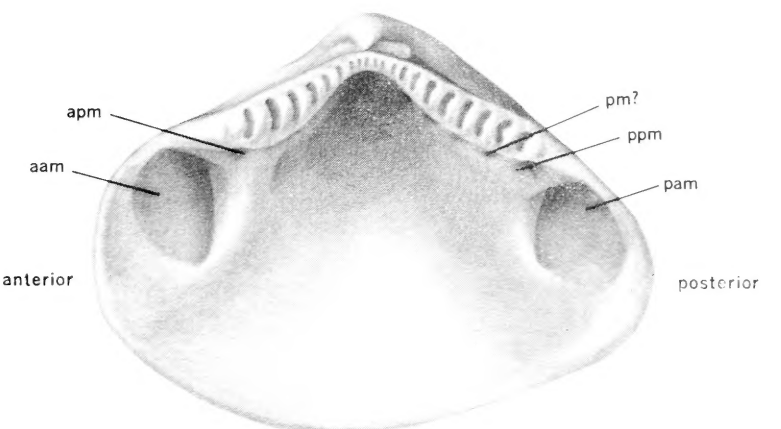

Figure 2. *Tancrediopsis cuneata* (Hall). Generalized interior view of right valve showing anterior adductor muscle scar (aam), anterior pedal muscle scar (apm), posterior pedal muscle scar (ppm), posterior adductor muscle scar (pam), and additional possible pedal or visceral muscle scars along posterior dorsal margin (pm?).

position: "Allumette limestones" [probably Rockland beds of the Ottawa formation, Middle Ordovician (lowest Trenton stage of Twenhofel, 1954)].

The location of Hall's original figured specimen is unknown, for it is not listed in the type catalogues of either the American Museum of Natural History or the New York State Museum (Whitfield and Hovey, 1898-1901; Clarke and Ruedemann, 1903), the two institutions which contain most of Hall's original material. The specimen may be as yet unrecognized among the non-type material at these or other institutions. Hall's original figure leaves little room for doubt, however, as to the identity of the species in question, and the designation of a neotype therefore seems unnecessary.

Material. This revised description is based on 189 silicified valves. Fifteen of these are Salter's original types of *Ctenodonta contracta* from the collections of the Geological Survey of Canada, Ottawa, Ontario, Canada (catalogue No. 1171). The remaining 174 specimens are from the collections of the Peabody Museum, Yale University, New Haven, Connecticut, U. S. A. All of Salter's specimens and almost half of the Yale material (75 specimens) were collected at Paquette Rapids (between Allumette Island, Quebec and Ontario mainland, about three miles south of Waltham, Quebec, Canada; see Kay, 1942, pl. 6) which is the original type locality of both *Tellinomya cuneata* Hall and *Ctenodonta contracta* Salter. The remaining Yale specimens (99) were collected from Middle Ordovician limestones of approximately the same age exposed at Pointe Bleue on the shores of Lake St. John, about five miles north of Roberval, Quebec, Canada (see Dresser, 1916, map 184A). Both Yale collections were made in 1903 by C. E. Beecher and P. E. Raymond. The original specimens studied by Salter were collected by W. E. Logan in 1845. The distribution of specimens of *Tancrediopsis cuneata* at these institutions and localities is shown in more detail in Table 1.

The material shows considerable variation in the quality of the silicified preservation. In some specimens the whole valve is preserved, but many valves were incompletely replaced by silica and do not show the entire outline. The fragile posterior extremity is commonly missing, but the heavy hinge plate and dentition are almost always preserved. The specimens from

TABLE 1

Distribution of specimens of *Tancrediopsis cuneata* (Hall) used in this study. For consistency, each valve of articulated individuals is counted as one "specimen."

Locality and Source	Right valves	Left valves	Articulated valves	Total specimens
Paquette Rapids				
Yale Peabody Museum...	44	29	2	75
Geological Survey of Canada.....	6	7	2	15
Pointe Bleue, Lake St. John (All Yale Peabody Museum).....	19	20	60	99
Totals.....	69	56	64	189

Lake St. John are generally more coarsely silicified and show fewer morphologic details than do those from Paquette Rapids.

Occurrence. The species is known with certainty only from the type locality and the Lake St. John locality mentioned above, both of which probably represent horizons in the middle part of the Middle Ordovician (lowest Trenton stage of the American standard, approximately lower Caradoc of the European standard, see Twenhofel, 1954). Several additional Ontario and Quebec occurrences are listed by Wilson (1956, p. 23), and the species may be represented in the Ordovician of Nevada (Walcott, 1884). Restudy of other important Ordovician pelecypod faunas may prove the species to be more abundant and widespread than is apparent from the evidence now available. In most such faunas nuculoid forms are not silicified, but are preserved as internal or composite molds (see McAlester, 1962). For this reason, an artifical internal mold of a well-preserved, silicified specimen of *T. cuneata* has been figured here to facilitate comparison with other faunas (fig. 47).

Discussion. There has been considerable confusion in the identification of Salter's species "*Ctenodonta contracta*" and other closely related species from the Paquette Rapids locality. The Yale collections from this locality contain about 700 silicified nuculoid specimens, and an analysis of these specimens has revealed that at least seven species of nuculoids occur in appreciable numbers at Paquette Rapids. Several additional nuculoid species probably also occur in the fauna but are quite rare and are represented by only a few specimens from the Yale collections. Five of the seven common species are distinctive and cause little confusion in identification. Wilson (1956, pl. 2) illustrates four of these distinctive species, which are identified by her as: *Ctenodonta astartaeformis* Salter, *Ctenodonta levata* (Hall), *Ctenodonta nasuta* Hall, and *Ctenodonta logani* Salter. A fifth common species, a small *Palaeoneilo*-like form, is not mentioned by Wilson and may be as yet undescribed.

It is the final two common nuculoid species in the Paquette Rapids fauna which are easily confused. Both are medium-sized (for nuculoids), thick-shelled forms with contracted posterior extremities, strong adductor impressions, and similar patterns of dentition. Analysis of the large Yale collections shows that the two forms do, however, show consistent and distinct differences in shape, which are most obvious from comparing the shell exteriors. To facilitate comparison the two species will be referred to here as "Form A" and "Form B." Form A has more central umbones, a more elongate and gently-sloping posterior constriction, and a differently shaped anterior-ventral and anterior margin. Internally, the differences are less distinctive, but the more central umbones, less abrupt posterior constriction, and longer posterior dentition of Form A can usually be recognized. Form B also seems to have lacked the very fine, pustulose, concentric sculpture seen on well-preserved specimens of Form A. Form B also appears to have had weaker and somewhat differently oriented pedal muscle scars. In Form A the chevron-shaped teeth point toward the umbo, whereas they tend to point away from the umbo in Form B. These differences in shape and sculpture are shown in fig. 3.

There are no morphological intermediates between these two common forms in the Paquette Rapids fauna, and they certainly represent two closely related sympatric nuculoid species. Among approximately 700 identifiable nuculoid specimens from the locality in the Yale collections, about 250 (36 per cent) are form B, 75 (or about 11 per cent) are Form A, and the bulk of the remainder (about 375 specimens or 53 per cent) represent the five additional species mentioned above. The lectotype of Hall 's species *Tellinomya cuneata* is readily recognizable

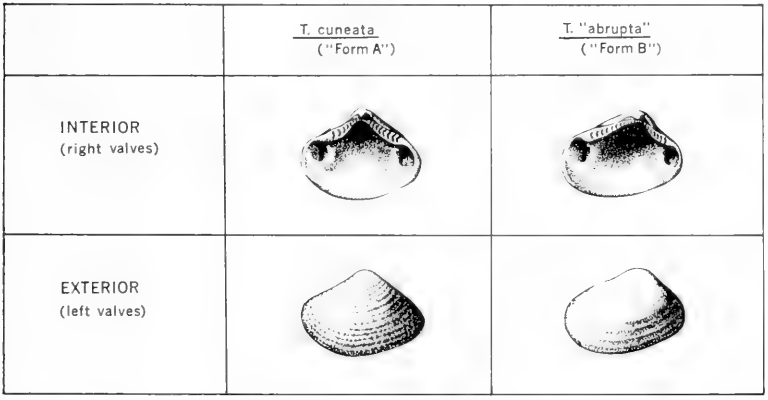

Figure 3. Internal and external views showing morphologic differences between the closely related sympatric species *Tancrediopsis cuneata* (Hall) and *Tancrediopsis "abrupta"* (Billings).

from the original figure as belonging to Form A (sub-central umbones, elongate posterior, etc.) as are also the lectotype and other original specimens of *Ctenodonta contracta* Salter. The lectotypes of both species are from Paquette Rapids, and there is little doubt that the two names are synonyms.

Hall's name "*Tellinomya cuneata*" was not formally proposed as a new species, but was merely first listed in explanation of figures of "*Tellinomya*" [=*Ctenodonta*] in a discussion of the genus (1856) which was later reprinted in two forms (1857a, 1857b). Characters of the species are, however, briefly mentioned in Hall's text (p. 392 in the original report). The figures and discussion of the species in Hall's report cer-

tainly constitute a valid description or "indication" of a new species as prescribed in the rules of nomenclature (see Stoll, 1961, p. 15), and Hall's name, which has three-years priority over *Ctenodonta contracta* Salter, is therefore accepted here as the correct name for the species. This strict usage of priority may violate the new "nomen oblitum" provision of the nomenclatural code which provides that "a name that has remained unused as a senior synonym in the primary zoological literature for more than fifty years is to be considered a forgotten name (nomen oblitum). . . [and] is not to be used unless the Commission so directs" (Stoll, 1961, p. 23). However, the application of the rule is ambiguous in this case because *Tellinomya cuneata* has appeared in what is presumably the "primary zoological literature" as an incorrectly suppressed senior synonym of *Ctenodonta contracta* within the past fifty years (Bassler, 1915, p. 302). In addition, the prescribed procedure for applying the rule is extremely cumbersome and in my opinion will do more to create nomenclatural instability than to correct it because every "nomen oblitum" must be laboriously referred to the Commission for action. For these reasons I prefer a strict interpretation of the Law of Priority in this case (for additional objections and comment on the "nomen oblitum" provision see the Bulletin of Zoological Nomenclature, Volume 19, Part 6, 28 December, 1962).

The name of the second common species ("Form B") is not yet certain, but it appears that the lectotype of *Ctenodonta abrupta* Billings (1862; see also Wilson, 1956) is a representative of "Form B," and this may be the correct name for the species. These two closely related species (*Tancrediopsis cuneata* and "*Ctenodonta abrupta*") are certainly congeneric and thus *C. abrupta* would become *Tancrediopsis* "*abrupta*" (Billings).

In addition to these two common species of *Tancrediopsis*, a few other specimens from the Paquette Rapids fauna may represent closely related but very rare species. Several such specimens in the Yale collections do not appear to fall within the range of shape variation of either *T. cuneata* or *T.* "*abrupta*," but at present these specimens are too rare either to

warrant specific names or to cause confusion in the identification of *T. cuneata*. The original figured specimen of *Ctenodonta gibberula* Salter (1859, pl. 8, fig. 6) may represent one such species but, regrettably, the specimen appears to have been lost (see Wilson, 1956, p. 24). Pending the discovery of the original specimen or similar additional material, it does not seem prudent to recognize Salter's name. The two names *C. abrupta* Billings and *C. gibberula* Salter appear to be the only names proposed for Paquette Rapids specimens which are closely related to *T. cuneata*.

In comparison to the Paquette Rapids fauna, nuculoids are somewhat less common and more poorly preserved in the silicified fauna from Lake St. John, but the fauna does contain many articulated specimens which are rare at Paquette Rapids (see Table 1). The nuculoid species at Lake St. John all appear to be indistinguishable from those at Paquette Rapids, although the relative abundances differ at the two localities. At Lake St. John, *T. cuneata* is over three times as abundant as *T.* "*abrupta*" (99 vs. 30 specimens), whereas this situation is reversed at Paquette Rapids where *T.* "*abrupta*" strongly dominates (approximately 250 specimens vs. 75 specimens of *T. cuneata*).

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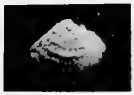
Figures 4-21. *Tancrediopsis cuneata* (Hall). A series of exterior views of silicified right valves showing variation in shape and sculpture. All figures are twice natural size. Precise locality information for the "Paquette Rapids" and "Lake St. John" localities is given in the text. YPM = Yale University Peabody Museum collections, New Haven, Connecticut, U.S.A. GSC = Geological Survey of Canada collections, Ottawa, Ontario, Canada.

Figure 4. YPM 22966, Lake St. John. Figure 5. YPM 22967, Lake St. John. Figure 6. YPM 22968, Lake St. John. Figure 7. YPM 22969, Lake St. John. Figure 8. YPM 22970, Lake St. John. Figure 9. YPM 22971, Paquette Rapids. The specimen lacks the anterior and posterior extremities. See also fig. 48. Figure 10. YPM 22972, Paquette Rapids. The specimen lacks the posterior extremity. Figure 11. YPM 22973, Lake St. John. Figure 12. YPM 22974, Lake St. John. Figure 13. YPM 22975, Paquette Rapids. The specimen lacks the anterior extremity. See also fig. 50. Figure 14. YPM 22976, Paquette Rapids. The specimen lacks the anterior and posterior extremities. Figure 15. YPM 22977, Paquette Rapids. See also figs. 52, 68. Figure 16. YPM 22978, Lake St. John. Figure 17. GSC 1171c, Paquette Rapids. One of Salter's original specimens of *Ctenodonta contracta*, figured by Wilson, 1956, as figs. 7 and 8 of pl. 2. See also fig. 70. Figure 18. YPM 22979, Paquette Rapids. The anterior part of the specimen is missing. Figure 19. GSC 1171k, Paquette Rapids. One of Salter's original specimens of *Ctenodonta contracta,* figured by Wilson, 1956, as fig. 9 of pl. 2. The specimen lacks the anterior extremity. Figure 20. GSC 1171e, Paquette Rapids. One of Salter's original specimens of *Ctenodonta contracta.* See also fig. 66. Figure 21. YPM 22980, Paquette Rapids. See also figs. 47, 55, 77, 79.



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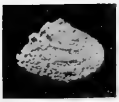

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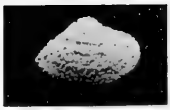

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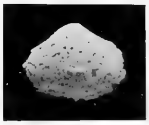

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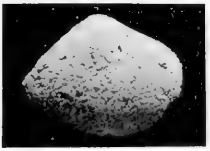

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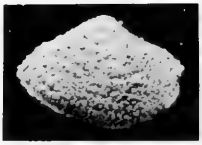

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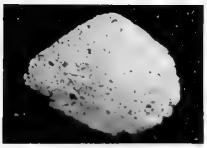

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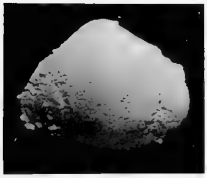

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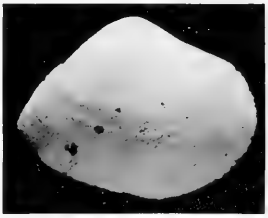

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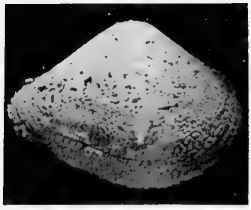

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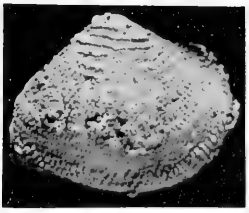

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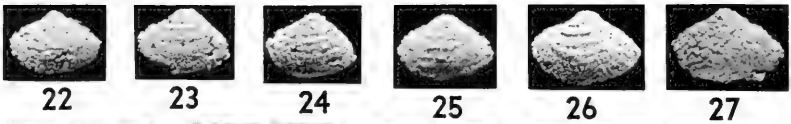
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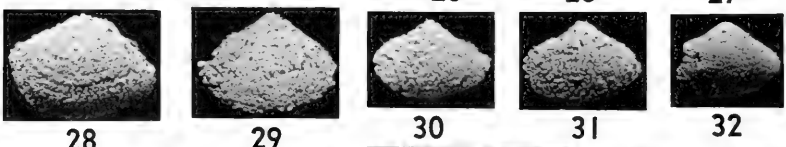
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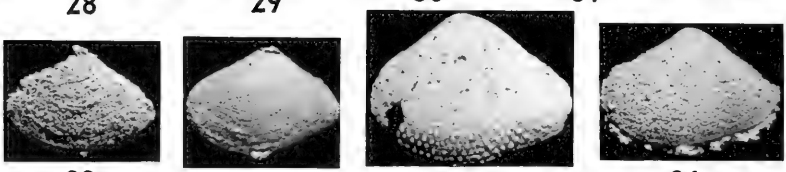
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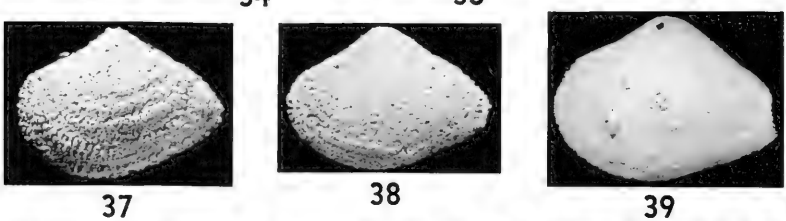
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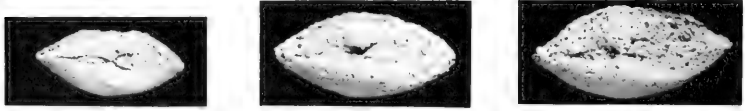
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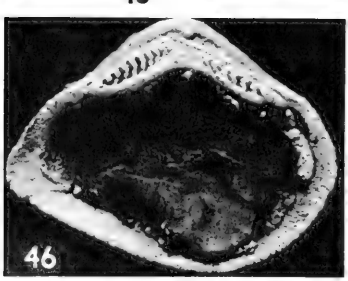
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Figures 22-47. *Tancrediopsis cuneata* (Hall). Figures 22 through 42 are a series of exterior views of silicified right valves showing variation in shape and sculpture. Figures 43 through 45 are dorsal views of three articulated silicified specimens (anterior end to left). Figure 46 is an interior view of the largest known specimen, a silicified left valve. Figure 47 is a latex internal mold of a silicified right valve showing the appearance of the species as normally preserved in non-silicified faunas. All figures are twice natural size. Precise locality information for the "Paquette Rapids" and "Lake St. John" localities is given in the text. YPM = Yale University Peabody Museum collections, New Haven, Connecticut, U.S.A. GSC = Geological Survey of Canada collections, Ottawa, Ontario, Canada.

Figure 22. YPM 22981, Lake St. John. Figure 23. YPM 22982, Lake St. John. Figure 24. YPM 22983, Lake St. John. Figure 25. YPM 22984, Lake St. John. Figure 26. YPM 22985, Lake St. John. Figure 27. YPM 22986, Lake St. John. Figure 28. YPM 22987, Lake St. John. Figure 29. YPM 22988, Lake St. John. Figure 30. YPM 22989, Lake St. John. Figure 31. YPM 22990, Lake St. John. Figure 32. YPM 22991, Paquette Rapids. The specimen lacks the anterior extremity. See also fig. 58. Figure 33. YPM 22992, Lake St. John. Figure 34. GSC 1171L, Paquette Rapids. One of Salter's original specimens of *Ctenodonta contracta*. See also fig. 43. Figure 35. GSC 1171j, Paquette Rapids. Figure 36. YPM 22993, Lake St. John. See also fig. 44. Figure 37. YPM 22994, Lake St. John. Figure 38. YPM 22995, Lake St. John. See also fig. 45. Figure 39. Lectotype of *Ctenodonta contracta* Salter, GSC 1171b, Paquette Rapids, figured by Salter, 1859, as figs. 5 and 5a of pl. 8. The specimen lacks the posterior extremity. See also figs. 61, 67, 75, 80. Figure 40. GSC 1171m, Paquette Rapids. One of Salter's original specimens of *Ctenodonta contracta*. The specimen lacks the anterior extremity. See also figs. 60, 73, 76. Figure 41. GSC 1171i, Paquette Rapids. One of Salter's original specimens of *Ctenodonta contracta*. See also fig. 69. Figure 42. GSC 1171d, Paquette Rapids. One of Salter's original specimens of *Ctenodonta contracta*. Figure 43. GSC 1171L, Paquette Rapids. One of Salter's original specimens of *Ctenodonta contracta*. See also fig. 34. Figure 44. YPM 22993, Lake St. John. See also fig. 36. Figure 45. YPM 22995, Lake St. John. See also fig. 38. Figure 46. GSC 1171a, Paquette Rapids. One of Salter's original specimens of *Ctenodonta contracta*. Figure 47. Latex cast of YPM 22980, Paquette Rapids. See also figs. 21, 55, 77, 79.

Figures 48-64. *Tancrediopsis cuneata* (Hall). A series of internal views of silicified valves showing dentition and adductor musculature. Figures 48 through 56 are right valves; figures 57 through 64 are left valves. All figures are twice natural size. Precise locality information for the "Paquette Rapids" locality is given in the text. YPM = Yale University Peabody Museum collections, New Haven, Connecticut, U.S.A. GSC = Geological Survey of Canada collections, Ottawa, Ontario, Canada.

Figure 48. YPM 22971, Paquette Rapids. See also fig. 9. Figure 49. YPM 22996, Paquette Rapids. Figure 50. YPM 22975, Paquette Rapids. See also fig. 13. Figure 51. YPM 22997, Paquette Rapids. Figure 52. YPM 22977, Paquette Rapids. See also figs. 15, 68. Figure 53. YPM 22998, Paquette Rapids. Figure 54. GSC 1171g, Paquette Rapids. One of Salter's original specimens of *Ctenodonta contracta*. See also fig. 72. Figure 55. YPM 22980, Paquette Rapids. See also figs. 21, 47, 77, 79. Figure 56. YPM 22999, Paquette Rapids. See also fig. 74. Figure 57. YPM 23000, Paquette Rapids. Figure 58. YPM 22991, Paquette Rapids. See also fig. 32. Figure 59. YPM 23001, Paquette Rapids. See also fig. 78. Figure 60. GSC 1171m, Paquette Rapids. One of Salter's original specimens of *Ctenodonta contracta*. See also figs. 40, 73, 76. Figure 61. Lectotype of *Ctenodonta contracta* Salter, GSC 1171b, Paquette Rapids, figured by Salter, 1859, as figs. 5 and 5a of pl. 8. See also figs. 39, 67, 75, 80. Figure 62. YPM 23002, Paquette Rapids. Figure 63. YPM 23003, Paquette Rapids. Figure 64. YPM 23004, Paquette Rapids. See also fig. 71.

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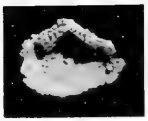

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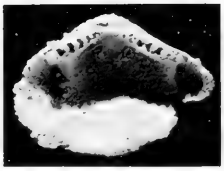

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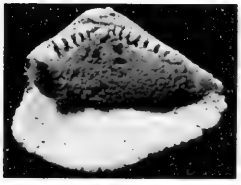

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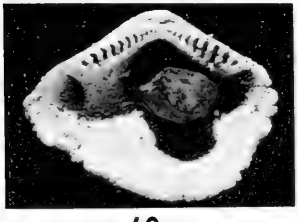

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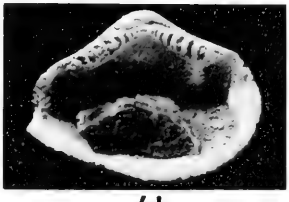

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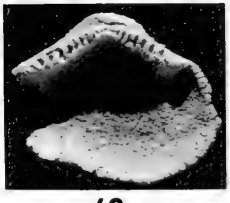

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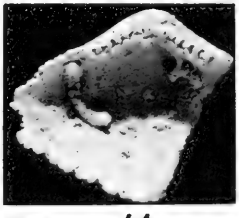

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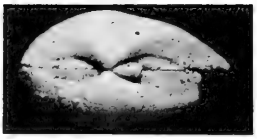

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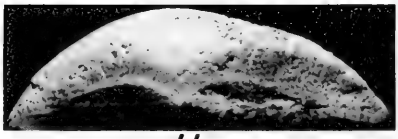

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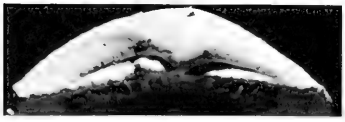

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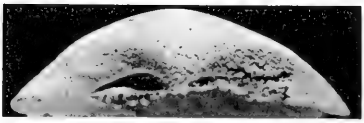

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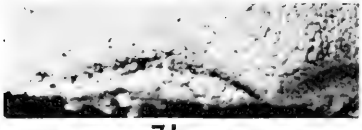

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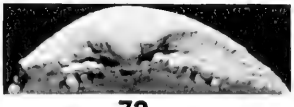

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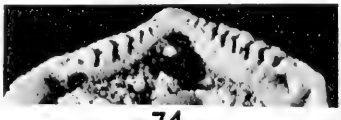

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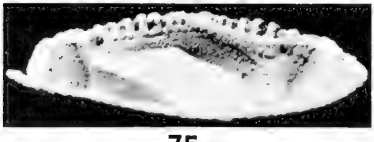

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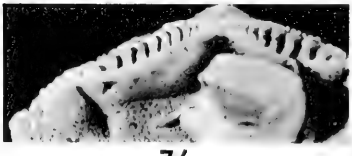

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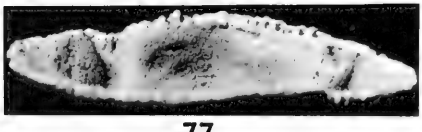

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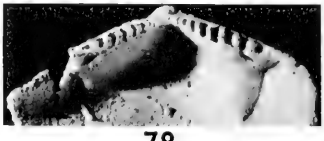

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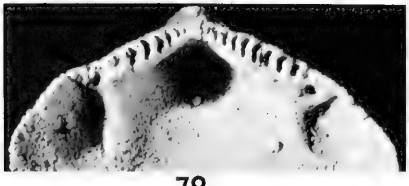

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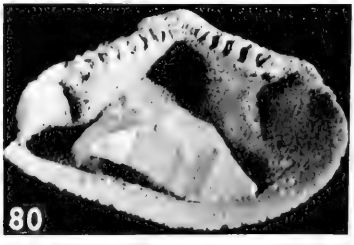

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Figures 65-80. *Tancrediopsis cuneata* (Hall). A series of enlarged views of silicified valves showing details of ligament, dentition, and musculature. All figures are three times natural size except Figure 65 (twice natural size) and Figure 71 (six times natural size). Precise locality information for the "Paquette Rapids" locality is given in the text. YPM = Yale University Peabody Museum collections, New Haven, Connecticut, U. S. A. GSC = Geological Survey of Canada collections, Ottawa, Ontario, Canada.

Figure 65. GSC 1171f, Paquette Rapids. One of Salter's original figured specimens of *Ctenodonta contracta,* illustrated by Salter, 1859, as figs. 4 and 4a of pl. 8. Dorsal view of articulated valves (anterior end to left) showing lunule, escutcheon, and silicified replica of ligament. Figure 66. GSC 1171e, Paquette Rapids. One of Salter's original specimens of *Ctenodonta contracta.* Dorsal view of right valve showing lunule, escutcheon, and silicified replica of ligament. See also fig. 20. Figure 67. Lectotype of *Ctenodonta contracta* Salter, GSC 1171b, Paquette Rapids, figured by Salter, 1859, as figs. 5 and 5a of pl. 8. Oblique dorsal view of left valve showing lunule, escutcheon, and silicified replica of ligament. See also figs. 39, 61, 75, 80. Figure 68. YPM 22977, Paquette Rapids. Oblique dorsal view of right valve showing lunule. See also figs. 15, 52. Figure 69. GSC 1171i, Paquette Rapids. One of Salter's original specimens of *Ctenodonta contracta.* Oblique dorsal view of left valve showing escutcheon and silicified replica of ligament. See also fig. 41. Figure 70. GSC 1171c, Paquette Rapids. One of Salter's original specimens of *Ctenodonta contracta,* figured by Wilson, 1956, as figs. 7 and 8 of pl. 2. Oblique dorsal view of right valve interior showing lunule, escutcheon, and silicified replica of ligament. See also fig. 17. Figure 71. YPM 23004, Paquette Rapids. Enlarged dorsal view of left valve showing lunule, escutcheon, and tiny perforations along posterior margin of escutcheon. See also fig. 64. Figure 72. GSC 1171g, Paquette Rapids. One of Salter's original specimens of *Ctenodonta contracta.* Oblique dorsal view of right valve showing lunule, escutcheon, and silicified replica of ligament. See also fig. 54. Figure 73. GSC 1171m, Paquette Rapids. One of Salter's original specimens of *Ctenodonta contracta.* Oblique dorsal view of left valve showing lunule, escutcheon, and dentition. See also figs. 40, 60, 76. Figure 74. YPM 22999, Paquette Rapids. Oblique ventral view of interior hinge region of right valve showing anterior and posterior pedal muscle scars and dentition. See also fig. 56. Figure 75. Lectotype of *Ctenodonta contracta* Salter, GSC 1171b, Paquette Rapids, figured by Salter, 1859, as figs. 5 and 5a of pl. 8. Ventral view of left valve interior showing dentition, adductor muscle scars, strong rounded anterior and posterior pedal muscle scars, and faint additional pedal? muscle scars below posterior dentition. See also figs. 39, 61, 67, 80. Figure 76. GSC 1171m, Paquette Rapids. One of Salter's original specimens of *Ctenodonta contracta.* Oblique ventral view of left valve interior showing dentition and posterior adductor and pedal muscle scars. See also figs. 40, 60, 73. Figure 77. YPM 22980, Paquette Rapids. Ventral view of right valve interior showing adductor muscle scars, strong rounded anterior and posterior pedal muscle scars, and faint additional pedal? muscle scars below posterior dentition. See also figs. 21, 47, 55, 79. Figure 78. YPM 23001, Paquette Rapids. Oblique ventral view of left valve interior showing dentition, anterior adductor muscle scar, anterior and posterior pedal muscle scars. See also fig. 59. Figure 79. YPM 22980, Paquette Rapids. Interior view of right valve showing dentition, adductor muscle scars, and pedal muscle scars. See also figs. 21, 47, 55, 77. Figure 80. Lectotype of *Ctenodonta contracta* Salter, GSC 1171b, Paquette Rapids, figured by Salter, 1859, as figs. 5 and 5a of pl. 8. Interior view of left valve showing dentition, adductor muscle scars, pedal muscle scars, and silicified replica of ligament. See also figs. 39, 61, 67, 75.